DOCUMENT RESUME

ED 202 680 SE 034 857

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TITLE Scientific Literacy in Georgia.
PUB DATE Apr 81
NOTE 32p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (54th, Grossinger's in the Catskills, Ellenville, NY, April 5-8, 1981). Contains occasional light type.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Differences; Elementary School Science; Elementary Secondary Education; Geographic Location; Grade 4; Grade 8; Grade 11; Racial Differences; School Size; *Science Education; Science Tests; *Scientific Literacy; Secondary School Science; Sex Differences; *State Surveys
IDENTIFIERS *Georgia; *Science Education Research

ABSTRACT

The purposes of this study were to: (1) assess the present level of scientific literacy of students in twelve public school systems in Georgia on an abbreviated form of the "National Assessment of Educational Progress Science Test"; (2) compare the performance of these students on specific test items with the performance of equivalent-grade students used in the test standardization; and (3) determine the relationship of certain demographic variables (gender, race, size of school system, and geographic location of school system) on the acquisition of scientific literacy. The present level of scientific literacy of the Georgia sample was determined to be below the mastery criterion of 70% accuracy for all three grade levels tested. In comparison of the Georgia sample with the national sample on selected science items, the scores of the Georgia sample were significantly different from the national sample of 60% of the items. Results also indicated significant differences for sex, race, school system size at all three grade levels, and for geographic location of the school system at the fourth- and eighth-grade levels. (Author/JN)

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SCIENTIFIC LITERACY IN GEORGIA

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A paper presented at the 1981 Annual Meeting of the National Association for Research in Science Teaching, Grossinger's, New York.

SCIENTIFIC LITERACY IN GEORGIA

Introduction

Education for scientific literacy should be a cummulative experience lasting a lifetime. It should provide individuals with the knowledge and skills for effective personal and family decision-making. The responsibility for preparing scientifically literate individuals rests with the schools. This is described as a major thrust of the public schools in Georgia. However, few attempts have been made to assess the attainment of scientific literacy (NAEP, 1969, 1972; Georgia Department of Education, 1978; AAP, 1972).

The purposes of this study were to assess the present level of scientific literacy of students in twelve public school systems in Georgia; to compare test item performance of these Georgia students with the performance of equivalent-grade students used in the test standardization; and to determine the relationship of certain demographic variables (gender, race, and size of school system) to the acquisition of scientific literacy skills.

Design of Study

The design used was a post-test only, descriptive approach. The study was a status survey to determine the scientific literacy of a stratified sample of students in selected Georgia schools.

Procedure of Study

Subjects in the study (N = 1676) were samples of fourth, eighth, and eleventh grade students enrolled in twelve public school systems in Georgia.

The twelve participating systems were divided into large or small based on reported average daily attendance. Using the Georgia School Directory, elementary and secondary schools were identified based on the presence of fourth, eighth, and eleventh grade classes in the schools. Within each system, one elementary school, one middle or junior high school, and one high school were randomly selected. Within each of the selected schools, two classrooms at the desired grade levels were chosen by the principal and/or the guidance counselor for participation.

In May of 1979, tests were mailed to each of the selected schools. The tests were administered by the classroom teacher to the students present on the scheduled day in the selected classrooms. The time required for testing was designed to be within one class period. The test was presented in printed form and on cassette tapes with all subjects marking their responses on the response sheets.

Instrument

The general dimensions of scientific literacy as measured by the National Assessment were used in assessing the scientific literacy of Georgia students. The Georgia Test of Scientific Literacy, the instrument used in this study, was developed from the National Assessment of Educational Progress Science Tests.

Items which had been previously released from the National Assessment Science Tests of 1969-70, 1972-73, and 1976-77 were used in the formulation of The Georgia Test of Scientific Literacy. The item pool contained 177 items for the fourth grade, 181 items for the eighth grade, and 174 items for the eleventh grade (NAEP, 1969-70; 1972-73; 1976-77). These items were grouped by age level into the five dimensions of scientific literacy to be measured:

biology, physical science, earth science, process skills and attitudes towards science and technology. All questions selected from the National Assessment exercises were the multiple-choice type, with five possible responses.

Instructions for The Georgia Test of Scientific Literacy were identical to those of the NAEP, directing students to select the best, or most nearly correct, response to each item but not to guess at a response. If students did not know anything about the material, they were instructed to mark the "I don't know" response. All responses were marked on the response sheets.

The time allocated for each item to be read and the responses marked on the separate response sheets were predetermined by the National Assessment. The time limits for The Georgia Test of Scientific Literacy were: 20 minutes for the fourth grade and 30 minutes for the eighth and eleventh grades. This time limit was based on:

1) the maturity level of the students to be tested;

2) the students' ability to listen to taped material; and

3) the amount of time available for testing without disruption of the school schedule.

The entire procedure of filling in the information sections of the response sheets and the administration of the test was organized to be finished within 40 minutes for fourth graders. A time frame of 45 minutes was set as a maximum for the eighth and eleventh grades (30 minutes for testing and 15 minutes for distribution of materials and completion of the information sections).

A pilot study was conducted using 693 students in two counties in Middle Georgia. There were 190 students in the fourth grade, 244 students in the eighth grade, and 259 students in the eleventh grade. The instruments were administered by classroom teachers and observations were made to identify difficulties that students experienced in the administration of the tests.

Validity

Since the same format and the same questions of the National Assessment were used in developing The Georgia Test of Scientific Literacy, content validity was assumed. However, the questions selected were submitted to a panel of three science educators to determine if the questions adequately represented the selected areas of scientific literacy were being assessed. The panel had a 95 percent agreement in specifying the area to which each question was assigned.

Reliability

The reliabilities of The Georgia Test of Scientific Literacy, based on the sample of 1676 subjects used in the study, were determined by use of ANLITH. The reliabilities ranged from 0.67 to 0.81 for the total sample and, when stepped down with the Spearman-Brown formula for 100 items, ranged from 0.82 to 0.92.

Findings and Conclusions

In relation to the first question "What is the present level of scientific literacy of students in twelve public school systems in Georgia?" in no instance did the sample of Georgia students in this study approach the relative standard of 70 percent mastery. Accuracy scores were determined for total and subtest scores on The Georgia Test of Scientific Literacy by dividing each of the group means by the respective number of items in the total test and in each of the subtests. The relative standard for specifying proficiency in scientific literacy was set at 70 percent mastery.

As shown in Table 1 the sample did not approach the standard of 70 percent mastery on the test or subtests. The range of accuracy scores on the total

Table 1

Means, Standard Deviation, and Accuracy Scores on Form A of
The Georgia Test of Scientific Literacy

Variable	Number of Items	Mean	Standard Deviation	Accuracy Scores (% correct)
Total Test				
Grade 4	33	16.88	4.25	51.15
Grade 8	58	25.94	6.30	44.72
Grade 11	55	21.30	6.73	38.73
Subtest 1 (Biology)				
Grade 4	10	4.40	1.68	44.00
Grade 8	16	8.46	2.47	52.87
Grade 11	19	9.12	3.15	48.00
Subtest 2 (Physical Science)				
Grade 4	6	4.12	1.16	68.67
Grade 8	12	5.28	2.12	44.00
Grade 11	11	4.02	2.18	38.55
Subtest 3 (Earth Science)				
Grade 4	6	2.47	1.46	41.17
Grade 8	6	3.01	1.45	50.17
Grade 11	3	0.96	0.87	32.00
Subtest 4 (Process Skills)				
Grade 4	3	1.41	0.86	47.00
Grade 8	4	2.60	1.06	65.00
Grade 11	3	1.03	0.84	34.33
Subtest 5 (Attitudes)				
Grade 4	8	4.47	1.54	55.88
Grade 8	15	6.58	2.47	43.87
Grade 11	15	6.16	2.60	41.07

test ranged from 38.73 (eleventh grade) to 51.14 (fourth grade). On the subtests, the accuracy scores on biology ranged from 44.00 (fourth grade) to 52.87 (eighth grade) while on physical science (subtest 2) the scores ranged from 38.55 (eleventh grade) to 68.67 (fourth grade). The range of accuracy scores on subtest 3 (earth science) was from 32.00 (eleventh grade) to 50.17 (eighth grade). Accuracy scores on the process skills test (subtest 4) showed a range in performance from 34.33 (eleventh grade) to 65.00 (eighth grade). The attitudes towards science and technology test (subtest 5) showed a range in performance from 41.07 (eleventh grade) to 55.88 (fourth grade).

Inspection of the frequency distribution (see Tables 2, 3, and 4) revealed that 100 or 16.5 percent of the 606 fourth graders in the sample reached or surpassed the 70 percent mastery level. At the eighth grade level, 8 students or 1.37 percent of the 585 students who were administered the test achieved mastery. Eleventh grade students taking the test were more unsuccessful with only 4 students or 0.82 percent of the 485 students achieving the criterion level of mastery.

The fourth grade tests indicated that on subtest 1 (biology), 127 students or 20.96 percent of the sample reached mastery. On subtest 2 (physical science), 378 or 62.38 percent reached mastery, and on subtest 3 (earth science), 179 or 29.54 percent of the sample achieved mastery. The level of 70 percent mastery was reached or surpassed by 283 or 46.70 percent of the sample on subtest 4 (process skills) and 228 or 37.62 percent of the sample achieved mastery on subtest 5 (attitudes). Thus, while approximately one-sixth of the sample reached or surpassed the mastery criterion on the total test scores for fourth grade test, close to two-thirds of the sample approached or surpassed the mastery criterion on subtest 2 (physical science). The poorest performance on the subtests at the fourth grade level was on subtest 1 (biology) where

Table 2

Frequency Distribution of Scores by Percent Accuracy on The Georgia Test of Scientific Literacy: Fourth Grade

Percent Accuracy	Total Test	Biology	Physical Science	Earth Science	Process Skills	Attitudes
90 - 99	3	34	69	23	77	15
80 - 89	25	36	152	59	88	81
70 - 79	72	57	157	98	118	132
60 - 69	123	99	70	50	81	131
50 - 59	160	125	76	76	84	121
40 - 49	111	132	42	74	79	81
30 - 39	88	72	24	77	23	30
20 - 29	18	34	14	61	34	14
10 - 19	5	17	2	51	17	1
0 - 9	1	0	0	37	5	0

Table 3

Frequency Distribution of Scores by Percent Accuracy on The Georgia Test of Scientific Literacy: Eighth Grade

Percent Accuracy	Total Test	Biology	Physical Science	Earth Science	Process Skills	Attitudes
90 - 99	0	6	13	14	115	2
80 - 89	0	17	22	59	53	8
70 - 79	8	72	97	124	130	24
60 - 69	62	62	102	68	111	74
50 - 59	130	141	89	89	66	165
40 - 49	188	134	129	67	24	122
30 - 39	131	85	52	75	23	67
20 - 29	53	37	73	46	24	100
10 - 19	12	23	23	24	15	16
0 - 9	1	8	5	9	23	7

Table 4

Frequency Distribution of Scores by Percent Accuracy on The Georgia Test of Scientific Literacy: Eleventh Grade

Percent Accuracy	Total Test	Biology	Physical Science	Earth Science	Process Skills	Attitudes
90 - 99	0	5	7	16	18	0
80 - 89	0	20	13	31	52	4
70 - 79	4	59	33	64	108	16
60 - 69	30	80	41	71	86	60
50 - 59	100	118	84	79	105	57
40 - 49	150	74	148	64	23	109
30 - 39	115	82	62	43	23	113
20 - 29	77	32	61	62	18	83
10 - 19	9	13	27	27	51	30
0 - 9	0	2	7	28	2	13

slightly more than one-fifth of the sample reached or surpassed the criterion.

At the eighth grade level, analysis of the scores on the subtests indicated that on subtest 1 (biology), 119 or 20.34 percent of the sample reached or surpassed the 70 percent mastery criterion; on subtest 2 (physical science), 132 or 22.56 percent, and on subtest 3 (earth science), 197 or 33.68 percent of the sample reached mastery. The level of 70 percent mastery was reached or surpassed by 298 students or 50.94 percent of the sample on subtest 4 (process skills) and by 58 students or 9.91 percent of the sample on subtest 5 (attitudes). Thus, while eight (8) or 1.37 percent of the students in the sample reached the mastery criterion on the total test scores at the eighth grade level, slightly more than half of the sample approached or surpassed the mastery criterion on subtest 4 (process skills). The poorest performance on the subtests at this grade level was on subtest 5 (attitudes), where slightly more than one-tenth of the sample reached or surpassed mastery.

Analysis of the subtests on the eleventh grade tests indicated that on subtest 1 (biology), 84 students or 17.32 percent of the sample reached or surpassed the 70 percent Mastery criterion; on subtest 2 (physical science), 53 students or 10.93 percent of the sample and on subtest 3 (earth science), 111 students or 22.89 percent of the sample achieved mastery. The level of 70 percent mastery was reached or surpassed by 84 students or 17.32 percent of the sample on subtest 4 (process skills); and by 20 students or 4.12 percent of the sample on subtest 5 (attitudes). Thus, while less than one-one-hundredth of the sample reached the mastery criterion on the total test scores of the eleventh grade test, close to one-fourth of the sample approached or surpassed the mastery criterion on subtest 3 (earth science). The poorest performance

on the subtests for this grade level was on subtest 5 (attitudes) where slightly less than one-twenty-fifth of the sample reached or surpassed the criterion.

These results seem to be in keeping with the limited research concerning the performance of samples of Georgia twelfth grade students in knowledge of scientific competencies. The Atlanta Assessment Project (1976), in studying the scientific understandings of twelfth grade students in selected public high schools in Georgia, reported that 29 percent of the students understood the scientific principles and thus "passed the objectives" of the AAP test on science and technology. Thus the present findings afford additional evidence of a general deficiency in scientific literacy among Georgia students. This deficiency is not just at the upper grade levels but begins at the elementary levels of education and continues through the upper levels.

Results showing poor performance are not limited to students in Georgia schools. Hamilton (1965) and Jaffarian (1968) assessed the scientific literacy of twelfth grade students in Kentucky and Wisconsin public schools, and found similary results. Other than the National Assessment of Education Progress, no research was located which attempted to determine and compare the scientific literacy of students at grades below the senior or twelfth year of schooling.

It because apparent from this study that Georgia is not meeting its goal of developing scientific literacy in its students. Why? Science is supposedly taught at all grade levels K through 8 with everyone required to "take it." Are the students being taught the concepts but are unable to learn them? How do you teach understanding? Or perhaps they are not being taught science? Perhaps the poor showing in the test is a function of the test items measuring content that is not being taught in the classroom. It is possible that the textbooks used in the schools of Georgia do not touch on

these concepts. As illustrated by the state testing program (Georgia Department of Education, 1979), the major emphasis in the elementary schools today appears to be on mathematics and reading to the apparent exclusion of other academic subjects.

Are students not learning because of poor teacher preparation? The pre-service education of the majority of elementary teachers in Georgia consists of 15 quarter hours of science, usually obtained in specially designed courses in biology and geology for the elementary teacher, and a 3 to 5 quarter hour course in science teaching methods. Many of these prospective teachers terminated their own science education in high school at the ninth grade with the one unit of science required for graduation. Thus, with limited background in science elementary teachers are expected to provide the background needed for students to become scientifically literate at the fourth grade. If these elementary students lack the background to build upon, can they be expected to achieve literacy by the eighth grade or the eleventh grade? Can it be assumed that teachers in the middle schools are better prepared to teach science and thus can overcome deficiencies in the students' background? Can the development of scientific literacy be achieved in students when they are required to have only one unit in science for graduation from high school?

Another possible cause for the low performance obtained on The Georgia Test of Scientific Literacy could be a result of the type of questions used. Of the 303 items used, 28 or 9.2 percent were at the lowest knowledge level, while 121 or 39.9 percent were at the comprehension level and 77 or 25.4 percent were at the application level (see Figure 1). Thus students who are still at the concrete level of development were asked to respond 65 percent of the time to higher level questions requiring more formal application and development. Perhaps the failure to achieve scientific literacy is not in the

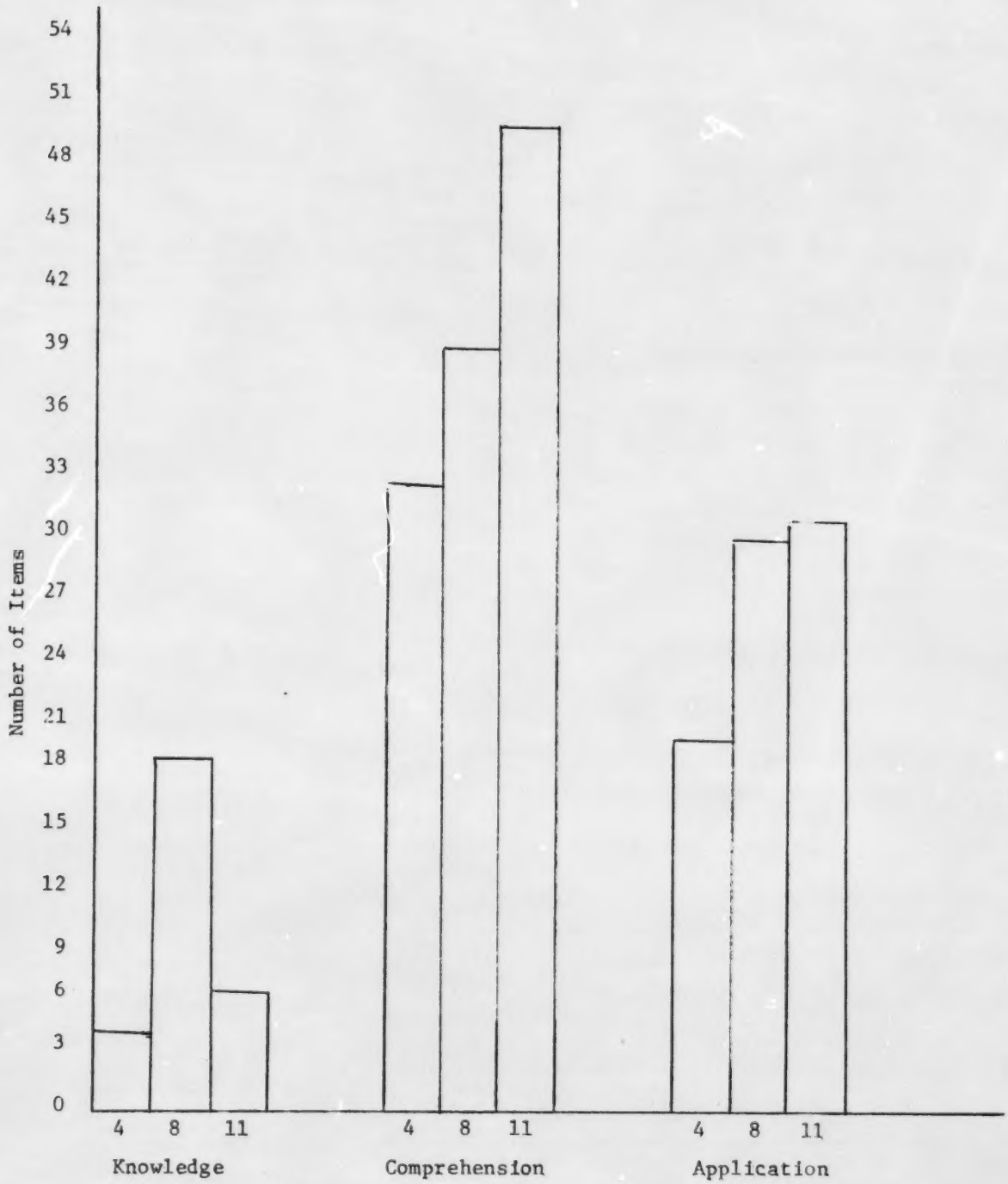

Figure 1. Number of items on The Georgia Test of Scientific Literacy by taxonomic classification and subject area total test.

teaching of the concepts but in teaching the application of these concepts to the everyday situations in which one would find oneself.

The results of the studies by Hamilton (1965), Jaffarian (1968), Fuller (1977), AAP (1976), and of this study are indications of the necessity of increased emphasis not only on science instruction in the public schools, but also emphasis on teaching more than the strict recall of facts. In order to produce scientifically literate individuals able to cope with the increasing influence of scientific technology on their everyday lives, the schools need to be teaching the application of science concepts.

Although the mean percent correct on all items in the national tests was slightly more than fifty percent, results from the National Assessment indicated that fourth graders showed a slight decline in scientific literacy from 1973 to 1977. Reports from all three national assessments indicated that the performance of students in the Southeast region of the United States has been consistently low. Fourth graders in the Southeast scored approximately four percentage points below the national average (NAEP, 1979). The results of the present study indicated that the performance of the fourth graders in this Georgia sample were consistent with previous reports of the low national and Southeast performance.

On a national level, the results of the National Assessment Science Tests indicated that eighth graders showed a slight gain in scientific literacy from 1973 to 1977. However, the eighth graders in the Southeast region of the United States scored 2 to 3 percentage points below the national average on the 1977 assessment. The results of the present study indicated that the performance of the Georgia students was lower than the national sample.

Nationally, the results released by the National Assessment indicated that eleventh graders scored significantly lower in all areas of scientific

literacy on all three assessments. The same pattern of decline was observed in the Southeast region of the United States. On some of the subtests the eleventh graders in the Southeast scored as much as 12 percentage points below the national average. The overall results of the present study indicated that the Georgia sample of eleventh graders scored lower than the national sample.

In general, the results of the present study indicated a general decline in scientific literacy which was substantially greater than the trend of the national sample. Students at the fourth grade are relatively more scientifically literate than their counterparts at the eighth and eleventh grades. Students at the eighth grade are more scientifically literate than their counterparts at the eleventh grade. Both nationally and in the Georgia sample, it would appear that students who have been exposed to eight or more years of science instruction show the greatest deficiency in scientific literacy.

In relation to the second question, "How does the performance of students in twelve public school systems in Georgia compare with equivalent-grade students in the normative sample?" the item performance of the three equivalent-grade groups in the standardization sample of the National Assessment of Educational Progress Science Test was obtained from the National Assessment Committee (NAEP, 1972, 1975, 1978). Item performance on the Georgia sample was assessed by the Analysis of Item and Test Homogeneity Program (ANLITH) which yields data relevant to percents passing and item test homogeneity.

Statistical procedures described by Garrett (1963) were used to compute critical ratios for each item. Critical ratios were calculated for comparison of observed proportions (Georgia sample) with the reference values (standardization sample). Any critical ratio which exceeded ± 1.96 was considered significant at the .05 level of probability. The results of these comparisons are presented in Figure 2.

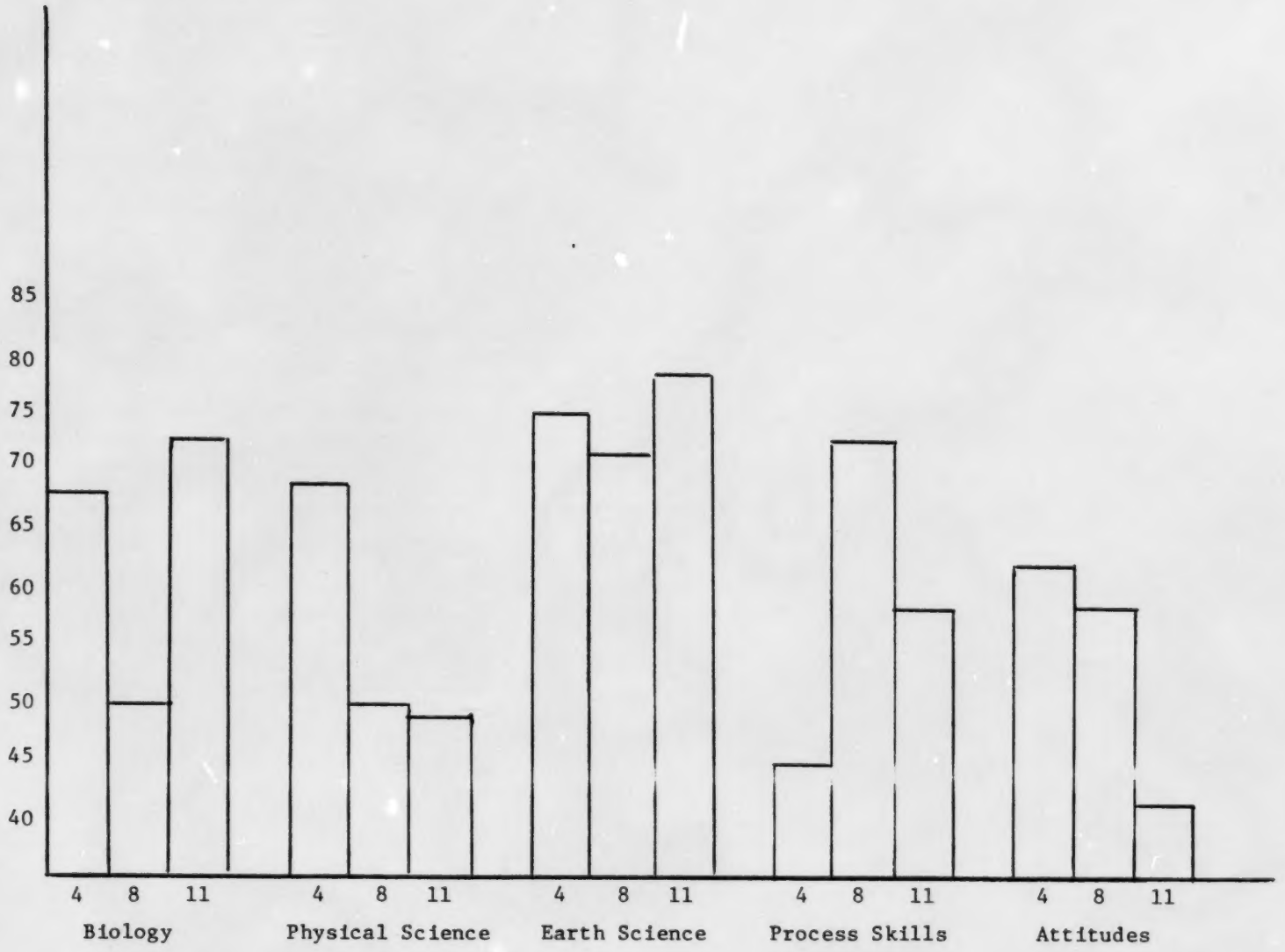

Figure 2. Percent of significant items by subtest and grade level.

The ranges in percentage of students passing by the Georgia sample and the National sample were similar at all grade levels. At the fourth grade, the Georgia percentage passing ranged from 7 to 96; the national percentage passing ranged from 6 to 96. At the eighth grade, the percentage passing for the Georgia sample ranged from 6 to 98 and the national percentage passing ranged from 8 to 97. At the eleventh grade, the percentage passing for the Georgia sample ranged from 8 to 96 while the national sample showed percentage passing ranging from 5 to 97.

Results indicated that the performance of Georgia students differed significantly from the performance of the national sample on 181 of the 303 items selected for testing. The performance of both groups was similar on the remaining 122 test items. The frequency of significant critical ratios by grade levels ranged from forty-five (45) at the fourth grade to sixty-nine (69) at the eleventh grade. The Georgia samples' item performance was similar to the item performance of the standardization sample on approximately 40 percent of the items when grade levels were disregarded; their performance was significantly differed (and lower) on approximately 60 percent of the items. Thus, the performance of the Georgia sample was found to be below the performance of the national sample.

In relation to the third question, "Do boys and girls show any difference in scientific literacy?" evidence was found to support that gender is a significant factor in demonstrated scientific literacy at all three grade levels. The performance of the males and females differed significantly on subtest scores at the fourth, eighth, and eleventh grades. Based on t-test analysis of total and subtest scores, males scored higher than the females in each case except two subtests in the eighth grade where females scored higher.

In the three previous assessments by the NAEP National Assessment, the results indicated that males consistently scored higher than females at all age levels with the gap increasing with age from about 2 percentage points at age 9 (fourth grade) to about 6 percentage points at age 17 (eleventh grade) (NAEP, 1979). Hamilton (1965) reported that gender did not seem to be a deciding factor in the attainment of scientific literacy by the Kentucky seniors tested in her study. Fuller (1977) reported that gender does not influence the ability of third grade students to acquire and/or retain the science concepts tested in her study. Husen, Fagerlind and Liljefors (1974) in their study of gender differences in science achievement and attitudes found that at grade three there was no performance differential between the boys and girls. In grade four, however, the boys did markedly better than the girls at all result levels. Grade four also showed large gender differences among the best students.

Results of the present study indicated that gender differences are observed as early as the fourth grade only in attitude. It was not until the eighth grade that gender differences began to occur in other areas. Is this because girls suddenly become uneducated about science topics? Could it be that cultural biases are beginning to occur? The old cliche that girls are not smart enough to learn science, could now be unconsciously taught to the girls. When they are no longer required to enroll in science courses, they shun them. The role model that is presented to them could also be a factor. In the summary report of the British Columbia Science Assessment the statement is made, "Science teaching at the secondary school level is overwhelmingly a male occupation. About nine out of ten secondary science teachers are male" (BSCA, 1978). A representative of the Georgia State Department of Education confirmed the same trend for Georgia teachers of

science at the secondary level. This representative stated that more males than females teach chemistry and physics in Georgia schools. Attitudes presented by their elementary teachers could also be a factor in influencing girls to shun advanced science courses. Whatever the reason for the significant differences in performance of males and females at the eleventh grade in the Georgia sample, these differences appear to be influenced by something that occurs between the eighth and eleventh grade.

In relation to the fourth question, "Is the race of students in twelve public school systems in Georgia related to their scientific literacy?" it was found that the variable of race is a significant factor that correlates with low performance in scientific literacy by Georgia students at all three grade levels tested. Total and subtest scores on The Georgia Test of Scientific Literacy were analyzed by race using t-tests for independent samples.

The t-test results indicated that the performance of black and white students differed significantly on the total scores of The Georgia Test of Scientific Literacy at all grade levels. In all instances of differences, the white students scored higher than the black students. Results of the t-test analyses for the subtest scores indicated significant differences for all five subtests at the fourth, eighth and eleventh grades. In all instances of significance the white students scored higher than the black students. These results are consistent with the results obtained by the National Assessment of Educational Progress in all three of their assessments. NAEP reports "performance of white students was consistently higher than that of black students. Differences in performance ranged from 12 to 18 points for the three age groups" (NAEP, 1979).

What is causing the disparity in the results of black and white students? Are the black students incapable of learning science? If so why

are there many black doctors, science educators, etc. in the nation? Would not these people be considered scientifically literate? Grant, Paige and Sinnot (1979) in their study of black and white mathematics achievement state that motivation remains a basic problem for black students. They quote a black counselor as saying "white students feel a great deal of academic pressure. They are trying to fulfill goals set by their parents; while black kids are concerned about meeting goals for themselves" (p. 111). Calloway (Grant, Paige, & Sinnot, 1979, p. 112) says "the expectation of the teacher is very low" when it comes to the black students. White students are expected to do better by the teachers and they do.

Koelsche and Newberry (1971) in a study of fourth and sixth graders in Georgia found that race was not a significant factor in the science interests of children. If black and white students have the same interests in science then why are there such significant differences, both in this study and in the national results, between blacks and whites in scientific literacy? National Assessment explains part of the decline in scores for blacks in the southeast by the massive integration of schools during the early 70's. However, this does not explain the poor showing of black students on The Georgia Test of Scientific Literacy. There must be other factors at work. Students in the fourth grade have attended integrated schools for their entire school career, while students in the eighth grade have attended integrated schools since 1971. The only group of students in this study who possibly had attended segregated schools would have been those in the eleventh grade, but even then, they have been in integrated classes since the early 1970's.

In relation to the fifth question, "Is the size of school system related to the acquisition of scientific literacy of students in twelve public school systems in Georgia?" based on the results of this study, the variable of

school system size is a significant factor influencing the acquisition of scientific literacy by the Georgia sample at the three grade levels tested. Total and subtest scores on The Georgia Test of Scientific Literacy were analyzed by school system size using t-tests for independent samples.

The results of the t-test analyses indicated that the performances of students enrolled in large school systems and those students enrolled in small school systems differed significantly on total test scores at all three grade levels tested. At the fourth grade, students in large school systems scored higher on the total test than students in the small school systems. However, at the eighth grade results were not conclusive. Some students enrolled in the small school systems scored higher than the students enrolled in the large school systems, while the reverse was also observed. At the eleventh grade students in small systems scored higher than those in large systems. This inconsistency in performance between the students in large and small systems appears to be evident at the national level. NAEP reports that across three assessments

> students in big cities consistently performed below the nation, while students in fringes around big cities performed above the nation. Performance of students in medium cities and small places tended to be at or near the national level, although the performance of 9-year olds in medium cities was somewhat erratic. Students in disadvantaged-urban communities performed 5 to 15 percentage points below the nation.... Students from average-urban communities performed about 4 to 8 points above the nation.... Students in extreme rural areas moved from well below the nation in 1969-70 to the national level in 1976-77 (NAEP, 1979, p. 26).

Systems in this study represented large cities, medium cities, and extreme rural communities; therefore, these results appear to be similar to those at the national level. Hamilton (1965) reported that no firm conclusions can be drawn relative to the scientific literacy of students from rural areas and those from suburban and urban areas of Kentucky. However, Hamilton also

reported that the size of the graduating class was not a contributing factor to scientific literacy for seniors in Kentucky schools.

Why are students in small systems performing better than their counterparts in large systems at the eighth and eleventh grades? Large systems consistently spend more money per student for educational purposes and the milleage rate for education is higher in the large systems. Are the small systems using their money more efficiently than the large systems? Teachers in small systems tend to be more closely in tune with the community and come in day to day contact with the parents of their students. In many instances, these teachers are members of the community who have returned to teach at the same high school or elementary school where they were once a student. Expectations appear to be greater for students in small systems. Teachers in large systems, by contrast, tend to be alienated from the community. There is not the involvement with the day to day living of students and parents. Many of these teachers in large systems never see their studens or their parents outside of the classroom. Since they have no knowledge of the community processes at work on their students, they tend to have fewer expectations of their students.

The large metropolitan areas are consistently waging battles with the community for more money for the schools. If this study is indicative, then the large systems should be finding out why their smaller counterparts appear to be doing a better job in preparing scientifically literate individuals with fewer dollars. The question does arise as to why are the fourth graders of the large systems performing better than the fourth graders in the small systems? Could it be a function of the curriculum? Are more of the larger systems providing science for their students at the lower grades and thus more opportunity for achieving scientific literacy?

There are many factors which could be involved in why students in small systems are outscoring their counterparts in large systems. These include teacher expectations of students; money spent per student; teacher involvement with students; etc. The inconsistency of these results would indicate that there are other factors at work besides just the size of the school system.

Implications for Science Teaching

While the scientific literacy of the Georgia students tested in this study was lower than that of the national sample, the factors of gender, race and school system size were variables that showed significant correlations with a students' scientific literacy. If this would be true for larger populations, to improve the scientific literacy of students these recommendations should be considered:

1. Provide science opportunities for females beyond the required and terminal ninth grade course. Since females constitute at least 50 percent of the population of the state, the failure to properly educate this group is a disservice to society. The "old South" ideal of the cringing-subservient female is past. If the state of Georgia is to maintain its rate of growth within the nation, females will have to be more aware of the role of science and technology in everyday life.

2. Provide science opportunities and instruction for black students at all levels. The many black scientists in the nation attest to the ability of blacks to learn and succeed in the area of science and technology. If given the opportunity, Georgia's black students are certainly able to achieve at the same level of these national scientists. Teachers will have to accept this and devise ways to incorporate the black students into the mainstream of learning.

3. Provide for similar opportunities and instruction for students in both large and small school systems. If, as this research indicates, there is a difference in the scientific literacy of students in these school systems then the same opportunities should be available for all students. Research should be undertaken to determine what school variables such as curriculum, teacher, or parent involvement, contribute to this noted difference in scientific literacy.

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